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DEVELOPMENT OF A LOGISTICS PRICE FILE. EXECUTIVE SUMMARY.(U)

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DEVELOPMENT OF A
LOGISTICS PRICE FILE

EXECUTIVE SUMMARY

for

U.S. Army Corps of Engineers

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The U.S. Army Corps of Engineers, North Central Division maintains a Route Split Model for forecasting projected traffic on the Great Lakes/St. Lawrence Seaway System. The three principal data inputs to the model are: (1) forecasts of potential flow into and out of the Great Lakes "hinterland"; (2) relative service attributes of Great Lakes and competitive routes; and (3) rate attributes of Great Lakes and competitive routes. The rate data base, noted above, is referred to as a Logistics Price File. This data base contains all

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the freight rate data required to allocate rate-sensitive traffic to either a Great Lakes or a competitive route. The Executive Summary provides an overview of: (1) structure of the Logistics Price File (LPF); (2) study approach; (3) validation techniques; and (4) study conclusions. Project output included development of a rate calculator model.

T A B L E   O F   C O N T E N T S

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Mr. John F. Wing, Vice President of Booz, Allen, was officer-in-charge of the assignment. The Director of Research was Leo J. Donovan. Timothy J. Consroe was Project Manager, assisted by Dagfinn M. Hansen. Dr. Edwin H. Draine of the University of Illinois acted as a Consultant to Booz, Allen on this study.

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

1. INTRODUCTION

The U.S. Army Corps of Engineers maintains a Route Split Model (RSM) to predict the flow of commodities within the Great Lakes/St. Lawrence Seaway system. The model is a tool for forecasting projected traffic on the system attributable to alternative system improvement programs.

The three principal data inputs to the model are:

- Forecasts of the potential flow of commodities into and out of the Great Lakes "hinterland"
- Service attributes of Great Lakes and competitive routes
- Cost attributes of Great Lakes and competitive routes

The commodity flow forecasts identify all movements which may have an origin or destination in the Great Lakes hinterland, which is the geographic area served by the Great Lakes system. The model uses the service and cost attributes above to allocate those flows to either a Great Lakes or an alternative routing.

The cost data base, noted above, is referred to as a Logistics Price File. This data base contains all the freight rate data required to allocate rate-sensitive traffic to either a Great Lakes or a competitive route. The development of the Logistics Price File (LPF) is documented in a two-volume report. This volume, the Executive Summary, provides an overview of the:

- Structure of the LPF
- Study approach
- Validation techniques
- Study conclusions

The second volume of the final report is the Technical Report which describes the study approach in detail and documents the development of all rate information.

2. STRUCTURE OF THE LPF

In this section the structure of the LPF is summarized, and the basic geographic and commodity units used in the Route Split Model are identified. It was necessary to maintain the geographic and commodity units of the RSM in the LPF in order to provide complete compatibility between the LPF and the model itself.* Terminology defined below to describe the LPF is used throughout the remainder of the report.

(1) Commodity Units

The basic commodity unit in the model is a commodity family. Every commodity potentially moving within the Great Lakes has been classified into one of 37 families. These families are identified in Appendix A of the Technical Report. There are 22 bulk families; the major bulk families are homogeneous. There are 15 general cargo families, all of which are highly diversified.

(2) U.S. Origins and Destinations

General cargo origins and destinations (O/D's) are defined in terms of 19 hinterland States. Bulk cargo O/D's are identified by BEA's.** The prime hinterland is assumed to consist of 84 BEA's. In addition, the fourteen BEA's which border the Great Lakes directly were subdivided further to twenty sub-areas, producing a total of 90 primary inland O/D's. A limited number of movements involve 99 other BEA's outside the prime hinterland.

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* This compatibility was required because the Route Split Model became operational in early 1976, while this study was conducted more than a year later. Development of a structurally different LPF would have required substantial modification to the Route Split Model.

** Economic areas defined by the U.S. Department of Commerce, Bureau of Economic Analysis. In this system the entire continential U.S. is divided into 171 BEA areas.

(3) Canadian Origins and Destinations

Eleven areas in Canada which border on the Great Lakes are identified in the commodity forecasts. In the RSM Canadian origins and destinations are not traced inland beyond these lakeside areas.

(4) Overseas Regions

Foreign trade is defined in terms of nineteen trade regions. These regions and the regions described above are given in Appendix B of the Technical Report.

(5) The "ODC" Concept

The commodity flow forecasts of the RSM are expressed in terms of the geographic and commodity units given above. A potential flow is defined by its origin area, destination area and commodity family. This flow is therefore referred to as an "ODC". There are 6852 ODC's with cargo in the RSM;* competitive rate information was required for these ODC cells.

Sample ODC's are shown in Table 1 below.

TABLE 1
ODC Definition

	Origin (O)	Destination (D)	Commodity (C)
Bulk:	BEA 68	BEA 72	Iron Ore
	BEA 68	BEA 76	Iron Ore
General Cargo:	Illinois	Northern Europe	Steel products
	Ohio	Northern Europe	Steel products
	Ohio	Northern Europe	Electrical machinery

Note: Each of the five combinations above forms an "ODC" (Origin, Destination, Commodity)

* There are more than 2 million theoretical ODC combinations.

(6) Potential Routes and Component Routes

Table 2 summarizes the different types of routes for which rate information was developed. As shown in the Table, one ODC (e.g. domestic bulk) may require as many as six cost elements, including three freight rates. Table 3 illustrates the approximate number of component freight rates (excluding terminal charges or Seaway tolls) which were calculated in order to fill the 6852 ODC cells.

3. SUMMARY OF APPROACH

The basic methodology for providing the 17,000 through rates required to complete the LPF involved two principal phases. The first phase was development of a rate calculator model capable of producing any land or water freight rate based on the origin and destination points of the movement and the characteristics of the commodity. This model consists of a series of rate calculator equations developed by regression analysis of approximately 2000 actual freight rates. These equations are supplemented with a file of rates for a limited number of movements which were not subjected to statistical analysis. The second phase of the approach involved developing techniques to use the rate calculator model to produce through rates compatible with the geographic and commodity specifications of the RSM and reflecting current cost differentials for competitive routes. Key elements of this two-phase approach are described below.

(1) Rate Calculator Model

The rate calculator model will estimate the freight rate for any commodity movement potentially involving the Great Lakes system. Rates for a commodity are provided for all modes of carriage normally used to transport that commodity.

An important factor influencing the level of freight rates is shipment size. Normally per unit rates decrease as minimum lot sizes increase. Table 4 summarizes the modes and shipment sizes foror which the model will produce overland freight rates.

TABLE 2
RSM Route and Cost Elements

Cargo	Movement	Route	Inland Transport Charges to Port*	Terminal Charges	Waterborne Costs	Seaway Tolls	Terminal Charge	Inland Transport Charges to Dest.**	No. of ODC's
General	Overseas	G.L.	●	●	●	●			1710
		Comp.†	●	●	●				
	Lakewise	G.L.	●	●	●	o	●	●	185
		Comp.						●	
Bulk	Overseas	G.L.	o	o	●	●			3433
		Comp.†	●	●	●				
	Lakewise	G.L.	o	o	●	o	o	o	1524
		Comp.						●	
									6852

Key: ● Always required
o Sometimes required depending on origin or destination

"G.L." is Great Lakes route
"Comp" is competitive route

* For overseas movements this rate component represents the overland movement between a U.S. or Canadian point and the port of loading (exports) and unloading (imports).

** Direct haul from origin to destination.

† The competitive overseas routes analyzed involved U.S. and Canadian ocean ports.

TABLE 3
LPF Component.Rates

Cargo	Movement	Route	Mode	No. of ODC's	Average No. of Rates Per ODC*	Component Rates	No. of LPF Records**
General	Overseas	G.L.	BB	1710	2	3420	1710
			CTR		2	3420	1710
		COMP	BB		2	3420	1710
			CTR		2	3420	1710
	Lakewise	G.L.	BB	185	1.5	278	185
			CTR		1.5	278	185
		COMP	BB		1	185	185
			CTR		1	185	185
Bulk	Overseas	G.L.		3433	1.5	5150	3433
		COMP			2	6866	3433
	Lakewise	G.L.		1524	1.5	2286	1524
		COMP			1	1524	1524
				6852		30432	17494

Abbreviations:

G.L. is Great Lakes route
COMP is competitive route
BB is break bulk rate
CTR is container rate

* Estimated
** Machine readable card images

TABLE 4
Mode and Shipment Size
(Overland Rates)

Commodity Group	Mode	Shipment Size
Grains	Rail	Single carload Multiple car/unit train*
	Truck	Truckload
	Barge	-
Coal***	Rail	Multiple car/unit train**
Iron ore	Rail	Multiple car/unit train*
Other dry bulk	Rail	Single carload
General Cargo (Break Bulk and containerized)	Rail	Single carload
	Truck	Truckload/trailerload

* Lowest prevailing multiple car rate is applied on a route-specific basis. If no multiple car rates are available single car rates are used.

** Multiple car rates are applied on a regional basis.

*** Barge transport is not a feasible mode for any coal movements identified in the Route Split Model.

The lakewise water rates produced by the model reflect vessel sizes normally used to transport each commodity. For iron ore, coal, limestone and grain the rates correspond to lakewise bulk carriers of 20,000-30,000 DWT. Other dry bulk rates correspond to a self-unloading vessel of about 11,000 DWT. Tanker rates correspond to Great Lakes tankers of 3,000-4,000 DWT. With the exception of some container traffic, ocean freight rates are not normally quoted as a function of shipment size. Container rates reflect full containerloads.

As indicated above, the model produces overland rates for competing modes over the same overland routes.

The method for selecting the rate and route for a commodity movement is summarized in the section below.

(2) Route Split Model Rates

The rate calculator model will produce a rate for a specific commodity over a specific route. This section summarizes the method used to produce rates which are compatible with the geographic areas and commodity families of the RSM.

The RSM rates developed for general cargo are weighted average rates which reflect the least cost through rate for a Great Lakes and for a competitive route. Development of weighted average rates required the following steps:

- Define commodity family profile. A mix of specific commodities for each hinterland state, commodity family and direction were developed.

- Define geographic profile. Production and market areas within each state were identified.

- Postulate Great Lakes and competitive routes. For each inland O/D city, natural tributary ports on the Great Lakes with general cargo facilities were identified. For overseas cargo, rates through ocean ports in six coastal ranges were calculated. (A through rate includes overland haul, terminal charges at the port and ocean freight.) The six coastal ranges include:

  - North Atlantic
  - South Atlantic
  - South Florida*
  - Gulf
  - Pacific
  - Canadian Atlantic

  For the overland component rate both truck and rail costs were calculated and the lower cost was used. The through rate for a

* Non-conference carriers operating between Miami and the Caribbean and Central America.

competitive route used in the weighting calculation below was the lowest rate selected from the six alternative ocean port routings identified above.

- Calculate weighted average rates. For one ODC the approach above will produce several through rates for each combination of inland city and specific commodity. A weighted average rate for the ODC was calculated to reflect this rate distribution.

Weighted rates were not calculated for bulk commodities because bulk commodity families and interior origins and destinations (BEA's) are relatively homogeneous. The limited heterogeneity of a few families was represented by weighted average commodity characteristics (stowage factor and value per ton). Thus bulk RSM rates correspond to point-to-point movements of specific commodities.

For each bulk commodity family a representative production city and market city was identified in each BEA. Natural tributary lake ports were identified for each such city. For a given routing the costs for alternative modes (rail, truck, barge, or pipeline if appropriate) were calculated and the least cost mode was used.

Several considerations shaped the approach above for developing Route Split Model rates, including:

- Freight rates are quoted for point-to-point movements of specific commodities, and are not directly related to the geographic areas and heterogeneous commodity families of the RSM.

- The large number of freight rates required (more than 30,000 overland and waterborne rates were entered into the LPF) rendered an individual fill-in approach infeasible.

- Satisfying the rate requirements of the RSM required only the establishment of relative rate advantages for competitive routes and not necessarily an extensive file of absolute rates.

The approach taken in this study reflects a compromise between the absolute accuracy of rate quotations and the extensive geographic and commodity diversification of the RSM.

4. VALIDATION TECHNIQUES

The objective of the study was to provide a measure of the relative cost advantage or disadvantage of the Great Lakes system compared to an alternative routing. The approach described above, which relies principally on the rate calculator model, has several potential sources of inaccuracies. The most critical element of the approach with respect to accuracy is the development of rate calculator equations based on a statistical sample of actual freight rates.

Validation tests were applied to the rate calculator equations to determine the goodness-of-fit of the equations and the implication of equation errors to cargo route allocations. The validation tests produced the following results:

- Calculated rates were usually accurate to within 20 percent of actual rates and consequently care should be exercised in using the equations to calculate individual absolute rate levels.

- The equations did not produce a rate bias in favor of either a Great Lakes or competitive route.

- Using the method employed in the Route Split Model to allocate cargo to competitive routes, significant inaccuracies in absolute calculated rates (37 percent) led to a corresponding "error" in tonnage allocation of only 4 percent.

These tests demonstrated that the rate levels reflected by the model on the whole are highly representative of the relative cost advantages or disadvantages of the Great Lakes system.

5. CONCLUSIONS

A preceding section summarized the structure of the Route Split Model as it simulates the routing characteristics of Great Lakes potential cargoes. That description indicated the wide commodity and geographic diversity

of lake-potential commerce. This diversification makes it impossible to draw specific conclusions concerning the competitive rate position of the Great Lakes system short of a comprehensive analysis of the subject. Such a comprehensive analysis would exceed the scope of this study.

This section summarizes general observations and conclusions developed in the course of the study. These conclusions are related to general trends which were observed during the study, and to the results of the regression analysis of actual freight rates.

(1) Significant Determinants of Freight Rates

The rate calculator equations described previously were produced by regression analysis of a sample of approximately 2000 actual freight rates. The variables or factors which are most significant in explaining the level of freight rates are summarized below.

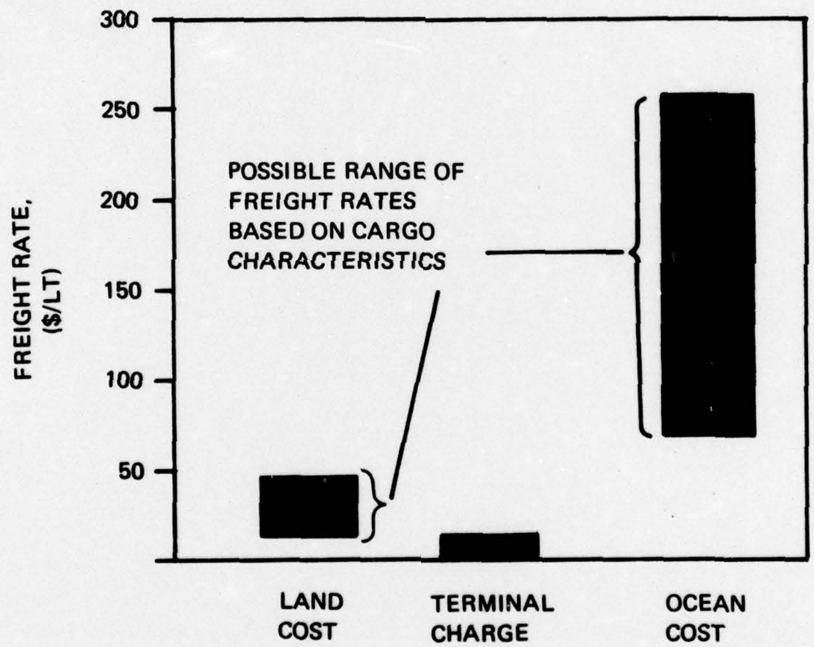
- Ocean rates. Individual conferences or trade routes are characterized by distinctive rate structures which reflect a unique combination of market factors. Consequently rate equations for specific trade areas, directions and U.S. coastal ranges were developed. In such cases distance may be considered constant, and the major factors determining rate levels are stowage factor and value per ton. In most cases relationships are non-linear.

- Overland rates. The most significant explanatory factor for overland rates is distance. To a lesser extent stowage factor and value per ton are positively correlated with rate. The regression analysis focused on rail and truck transportation; better statistical correlations were achieved for truck rates. The availability of barge transport on some routes had a depressant effect on rail and truck rates, indicating pricing structures which reflect market pressures and modal competition.

(2) Relative Magnitude of Rate Components

A complete overseas through rate is normally comprised of three rate components, an overland cost, a terminal charge and an ocean cost. Typical ranges for these components are shown in Figure 1. As shown in the figure, the single rate component which has the largest impact on the cost advantage of a given route is the ocean cost. In the figure the ocean freight varies between 60 percent and 90 percent of the total through rate.

FIGURE 1
Relative Rate Components



TRADE: U.S. (ALL COASTAL RANGES) TO NORTHERN EUROPE
MODE: CONTAINERIZED
COMMODITY CHARACTERISTICS:

- STOWAGE FACTOR (0.6-3.0)
- VALUE PER TON ($500-$3,500)

OVERLAND DISTANCE (0-600 MI.)

For domestic movements, a Great Lakes route in most cases involves an overland haul to a lake port and a waterborne haul. A competitive route involves a direct overland haul from origin to destination. The rates collected during the study indicate that on a per-mile basis most bulk commodities move at a lower rate by water than by land. This difference is illustrated in Table 5. Relative circuitry of competing routes and the availability of multiple car rail rates often determines whether a Great Lakes or competitive route offers a cost advantage.

TABLE 5
Representative Bulk Rates

All rates in cents per 100 miles
Rail rates are single carload unless otherwise noted

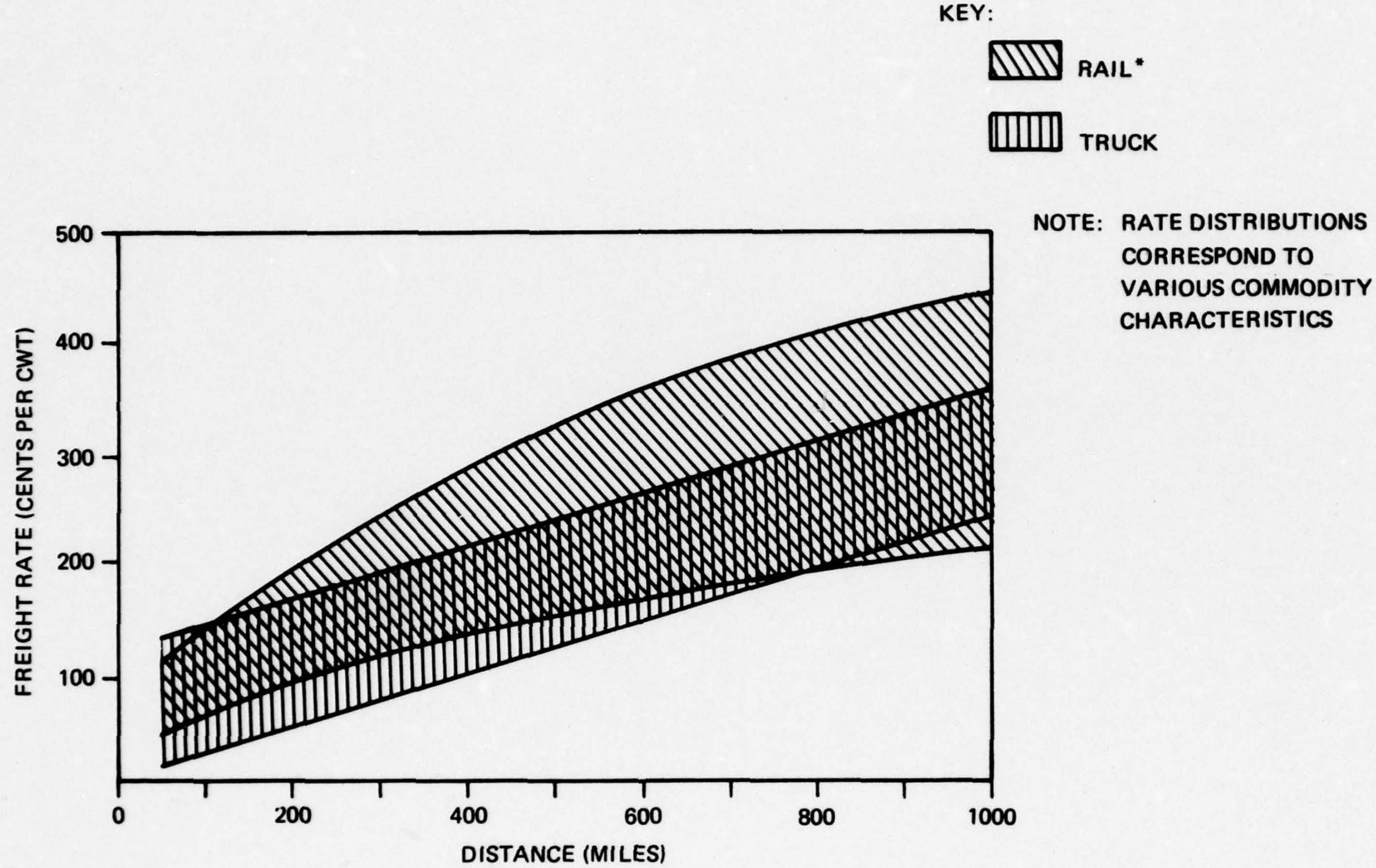
	Mode	
	Rail	Water
Coal	5**	1.5-2.3
Sand and gravel	18*	4.3*
Fuels	3.1†*	1.6*

* Distance 600 miles
** Multiple car rate
† Pipeline

(3) Cost Advantages of Competitive Overland Modes

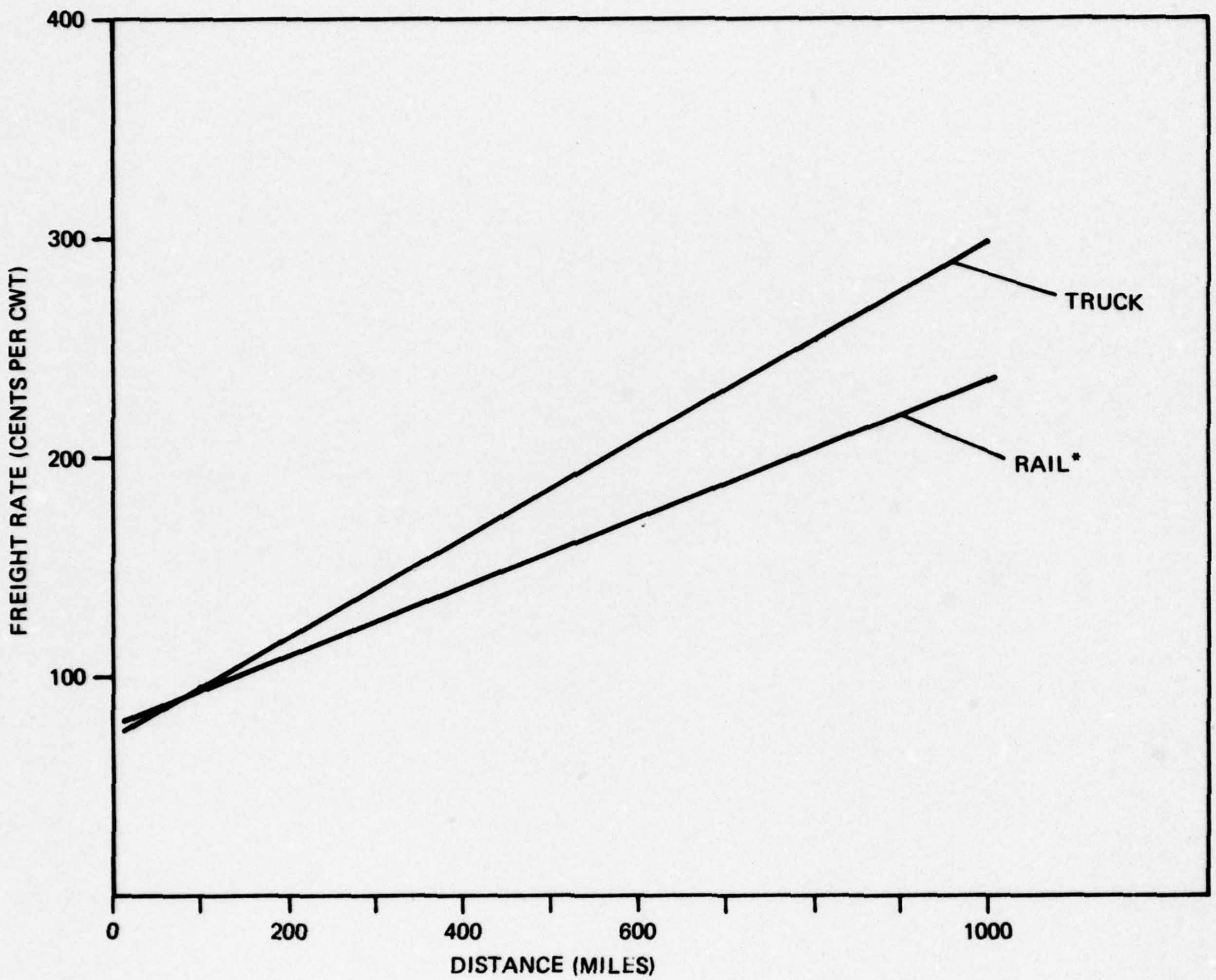
Both rail and truck are used frequently for transporting general cargo between interior points and Great Lakes or ocean ports. Figures 2 and 3 show average rate levels for break bulk and containerized shipments respectively. As shown in the figures, truck haul has the rate advantage at shorter distances, while rail has the long distance advantage. The distance at which both modes have approximately the same cost is about 100 miles for containerized shipments. The crossover distance for break bulk cargo depends on the characteristics of the commodity.

FIGURE 2
General Cargo Overland Costs
(Break Bulk)



*RAIL TARIFF AREA "5" AS DEFINED IN APPENDIX F.

FIGURE 3
General Cargo Overland Costs
(Containerized)



*RAIL TARIFF AREA "5" AS DEFINED IN APPENDIX F.

(4) Competitive General Cargo Overseas Rates

The cost advantage of a Great Lakes or alternative route depends on competitive through rates consisting of overland transport cost, terminal port changes and ocean cost. The level of each of these cost components is a function of commodity characteristics, and the location of the origin and destination of the movement in question. The data in Table 6, produced by the rate calculator model, presents a comparison of rates for three commodities which are significant in foreign trade involving the Great Lakes hinterland. Component rates are shown involving five potential U.S. origins or destinations for each commodity moving in trade with Northern Europe. Rates for the lowest cost ocean port route and Great Lakes route are provided.

The data in the table indicate that the Great Lakes route enjoys an overall cost advantage for every inland city and commodity in the table. The cost advantage varies between $5 per ton (about 5% of the competitive rate) and $46 per ton (about 28% of the competitive rate).

A summary analysis of the rates collected during this study has indicated that the data contained in the previous table are representative of the competitive position of the Great Lakes for overseas cargo. In general the Great Lakes system appears to offer through rates for many commodities which are equal to or lower than rates through competitive ocean ports.

This conclusion should be interpreted with the following qualifications. Rates were collected during the early part of the 1977 shipping season and reflect conditions at that time in a dynamic market. In particular the rates reflect the current container service in the Great Lakes which continues to have a major impact on prevailing freight rates. Finally, while generalizations concerning the rate attributes of the Great Lakes system may be made, rates for specific commodity movements must be determined on an individual basis.

* * * *

TABLE 6
Comparison of Through Rates
for Three Commodities

FOREIGN AREA OF ORIGIN OR DESTINATION: NORTHERN EUROPE

ALL RATES ARE FOR CONTAINERIZED CARGO IN DOLLARS PER LONG TON

COMMODITY	SITC	DIREC-TION	U.S. ORIGIN OR DESTINATION	G.L. PORT	LAND HAUL	TER-MINAL	OCEAN HAUL	TOTAL COST	ALTERN. PORT	LAND HAUL	TER-MINAL	OCEAN HAUL	TOTAL COST
IRON AND STEEL SLABS	6725	EXPORT	CINCINNATI	CLEVELAND	28	4	66	98	BALTIMORE	37	1	68	106
			INDIANAPOLIS	CHICAGO	26	5	66	97	BALTIMORE	39	1	68	108
			SPRINGFIELD	CHICAGO	26	5	66	97	BALTIMORE	46	1	68	115
			ST. LOUIS	CHICAGO	18	5	66	89	NEW ORLEANS	31	3	60	94
			DES MOINES	CHICAGO	20	5	66	91	NEW ORLEANS	42	3	60	105
PREPARED FRUITS AND NUTS	0539	EXPORT	CINCINNATI	CLEVELAND	28	4	104	136	BALTIMORE	37	1	128	166
			INDIANAPOLIS	CHICAGO	26	5	104	135	BALTIMORE	39	1	128	168
			SPRINGFIELD	CHICAGO	26	5	104	135	BALTIMORE	46	1	128	175
			ST. LOUIS	CHICAGO	18	5	104	127	NEW ORLEANS	31	3	118	152
			DES MOINES	CHICAGO	20	5	104	129	NEW ORLEANS	42	3	118	163
ALCOHOLIC BEVERAGES	1124	IMPORT	CINCINNATI	CLEVELAND	28	4	86	118	BALTIMORE	37	1	116	154
			INDIANAPOLIS	CHICAGO	26	5	86	117	BALTIMORE	39	1	116	156
			SPRINGFIELD	CHICAGO	26	5	86	117	BALTIMORE	46	1	116	163
			ST. LOUIS	CHICAGO	18	5	86	109	NEW ORLEANS	31	3	90	124
			DES MOINES	CHICAGO	20	5	86	111	NEW ORLEANS	42	3	90	135

The second volume of this report is the Technical Report which documents in detail the development of the Logistics Price File. That volume is organized into five chapters and several data appendices. Chapter I provides an overview of the study and contains much of the information presented in this Executive Summary. Chapter II documents the development of the rate calculator model. In Chapter III the methodology for using the model to produce RSM rates is described. Chapter IV describes validation tests which were applied to the products of the study, and provides observations concerning applications of the LPF. Chapter V recommends a methodology for updating the LPF.

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